CHANGES IN THE BEHAVIOUR OF DOUBLE-BROODED MACRO MOTHS IN YORKSHIRE

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Abstract

Current literature suggests that many species of Lepidoptera are bivoltine in the south and univoltine in northern England. A list is given of 36 species of macro moths where flight times in Yorkshire contradict published sources. Some of the most dramatic recent changes are illustrated by histograms. Climate warming is likely to be the main factor driving these changes.

Introduction

Many species of moths are well known to be bivoltine (having two broods) in the south and univoltine (having one brood) in the north. The factors governing this are not always obvious but seem to be largely due to the effects of increased temperature on larval growth rate along with altitudinal and habitat effects (Young, 1997). As many larvae feed nocturnally to avoid predators, longer nights further south may also provide more time for larval growth (Leverton 2004). Genetic factors are also involved and there may be positive benefits in having only one brood where the climate is uncertain (Leverton, 2001).

Sutton and Beaumont (1989) in Butterflies and Moths of Yorkshire stated "only a few moths and butterflies are regularly double-brooded this far north" and gave Early Thorn *Selenia dentaria* and Small Square-spot *Diarsia rubi* as examples. This may have been true at the time, but in the 17 years since the book was written, the distribution and behaviour of many species has altered dramatically. In the absence of any other contender, climatic warming is likely to be the main factor driving these changes.

Analysis of records

In Watsonian Yorkshire (Vice-counties 61 to 65), all moth records are collated and computerised using *MapMate* recording software. This has resulted in a database of almost half a million moth records being available for study. These are nearly all in the 25 years between 1980 and 2005 as many historical records have not yet been entered. Detailed flight-time histograms can now be produced, and these act as a useful aid in helping to decide whether moths are univoltine or bivoltine. By the end of 2005 we can safely say that at least 57 species of macro moth regularly caught in Yorkshire are now bivoltine every year, and a further 22 species may have a partial second brood in some years. This is a far cry from the situation in 1989. Many of these changes appear to be part of a long term trend and not just responses to unusually warm summers such as 2003.

The boundary between univoltine and bivoltine species is constantly moving and may be difficult to define or summarise. Information regarding flight season in commonly used field guides can be misleading. The data in Skinner (1984) is now

very out of date, and most people recording moths might use Waring and Townsend (2003). This new field guide although excellent in many respects, contains some arguable flight time data, some of which seems to be unchanged from that in Skinner. Phrases such as "double-brooded in southern England" or "two broods in southern Britain" are often used, but these geographical zones are not defined in the text and in most cases it is not clear where the south ends and the north begins.

The following species notes list the main examples where current flight times in Yorkshire contradict published sources. I have concentrated on macro moths as accurate flight time details on many of the microlepidoptera are fragmentary.

"W" refers to flight times as stated in Waring and Townsend

"Y" refers to the situation in Yorkshire

Geometridae

Birch Mocha *Cyclophora albipunctata* (Hufnagel)

W Two generations in the south, May/June and late July/August.

Y Not a common moth in Yorkshire and there are few sites where it occurs, but 23% of the total records occur in August/September and suggest a second brood.

Small Blood-vein *Scopula imitaria* (Hübner)

W Usually one generation July/August. Occasional small partial second generation in southern Britain September/October.

Y A second generation in Yorkshire most years from late August. Large in some years eg 35% of records in 2003.

Small Dusty Wave *Idaea seriata* (Schrank)

W Two generations in the south. One generation in the north.

Y Bivoltine every year, peaking in mid-July and late-September.

Riband Wave *Idaea aversata* (Linnaeus)

W Occasionally a partial second generation in the south, September/October.

Y Occasional September records in warm years are suggestive of a partial second brood.

Oblique Carpet *Orthonama vittata* (Borkhausen)

W Two generations in the south, one in the north.

Y Two clear, equal and widely separated broods.

Flame Carpet *Xanthorhoe designata* (Hufnagel)

W Two generations in the south, usually one in Scotland.

Y Clearly two broods each year.

Red Twin-spot Carpet *Xanthorhoe spadicearia* (Denis & Schiffermüller)

W Two generations in the southern half of England.

Y Always two well separated broods, the second much larger.

Dark-barred Twin-spot Carpet *Xanthorhoe ferrugata* (Clerck)
W Two generations in the southern half of England.
Y Again always two well separated broods, the second one much larger.

Small Phoenix *Ecliptopera silaceata* (Denis & Schiffermüller)
W Second generation occasional from Man northwards (NB the Isle of Man is at a similar latitude to North Yorkshire)
Y Always double-brooded in Yorkshire.

Green Carpet *Colostygia pectinataria* (Knoch)
W Two generations in southern England, one in northern Britain.
Y Double-brooded since 1997. Now a strong second brood each year.

Lime-speck Pug *Eupithecia centaureata* (Denis & Schiffermüller)
W Two overlapping generations in the south with a reduction in July. One generation in northern Britain.
Y A dip in records in July is suggestive of two overlapping generations.

Narrow-winged Pug *Eupithecia nanata* (Hübner)
W April to June with a partial second generation in southern Britain July/August.
Y May to August. Most records are July/August and suggest a strong second brood.

V-Pug *Chloroclystis v-ata* (Haworth)
W One generation in northern Britain
Y Bivoltine with a big second brood.

Yellow-barred Brindle *Acasis viretata* (Hübner)
W Two generations in southern Britain
Y Bivoltine. Second brood larger than the first.

Scorched Carpet *Ligdia adustata* (Denis & Schiffermüller)
W One generation in northern England and parts of Wales
Y Several late July to August records are highly suggestive of a second brood, although this is an uncommon moth in Yorkshire and more data is needed to be certain.

Peacock Moth *Macaria notata* (Linnaeus)
W Two generations in southern England, one generation elsewhere.
Y Again small numbers, but almost certainly bivoltine with most records occurring in August.

Purple Thorn *Selenia tetralunaria* (Hufnagel)
W One generation in northern Britain
Y Always bivoltine in April/May and July/August.

Engrailed *Ectropis bistortata* (Goeze)
W Two generations in southern Britain with occasional individuals of a partial third.
Y Bivoltine with a large second brood and a probable small third brood September/October.

Light Emerald *Campaea margaritata* (Linnaeus)
W Partial second generation in southern Britain and also recorded in Scotland.
Y Late moths first recorded in 1994 and now occur most years.

Notodontidae

Swallow Prominent *Pheosia tremula* (Clerck)
W One generation in northern Britain.
Y Bivoltine – usually overlapping broods.

Pale Prominent *Pterostoma palpina* (Clerck)
W One generation in northern Britain.
Y Bivoltine in May/June and a smaller generation in August.

Noctuidae

Flame Shoulder *Ochropleura plecta* (Linnaeus)
W One generation in northern Britain.
Y Bivoltine from 2000. 17% of records are now from the second brood.

Setaceous Hebrew Character *Xestia c-nigrum* (Linnaeus)
W One generation in northern England.
Y Regularly bivoltine since the early 1990s. The second brood now greatly outnumbers the first.

Nutmeg *Discestra trifolii* (Hufnagel)
W One generation from the Midlands northwards.
Y Always bivoltine with a big second brood in August.

Shears *Hada plebeja* (Linnaeus)
W A small second generation in August in the south.
Y August/September records in some years from 1996. A small but clear second brood – 3% of total records.

Cabbage Moth *Mamestra brassicae* (Linnaeus)
W In the north, probably only one generation.
Y Almost certainly two or three overlapping broods with records from April to October.

Bright-line Brown-eye *Lacanobia oleracea* (Linnaeus)
W A small second generation in southern Britain August/September.
Y A gradual increase in late records from the early 1990s onwards. A small bulge from mid August well into October indicative of a second brood comprising 3% of total records.

Broad-barred White *Hecatera bicolorata* (Hübner)
W Occasionally a small second generation in southern England in August.
Y 8% of records are in August and are highly suggestive of a partial second brood.

Campion *Hadena rivularis* (Fabricius)
W Two generations in southern England. One generation further north.
Y Bivoltine with overlapping broods.

Lychnis *Hadena bicruris* (Hufnagel)
W One generation from the Midlands northwards.
Y Now two large overlapping broods. Before 1990 the second generation was very small.

Common Wainscot *Mythimna pallens* (Linnaeus)
W One generation from the Midlands northwards.
Y Bivoltine. In the 1980s, second brood moths occurred in small numbers in some years. From 1994 a regular second brood has increased each year and from 2002 outnumbers the first brood.

Burnished Brass *Diachrysia chrysitis* (Linnaeus)
W A partial second generation in southern Britain.
Y Almost always bivoltine. Second generation comprising 10% of total records.

Gold Spot *Plusia festucae* (Linnaeus)
W Two generations in southern Britain (and occasionally in northern England)
Y Bivoltine with two overlapping broods; the second brood increasing every year is now much the larger, peaking at the end of August.

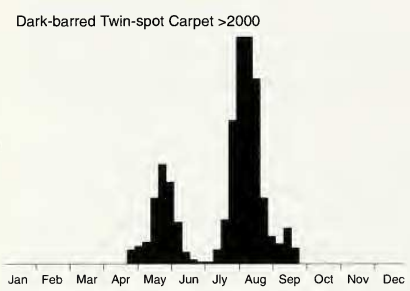
Straw Dot *Rivula sericealis* (Scopoli)
W June/July with a smaller second generation in southern Britain August/September.
Y Strongly double-brooded especially since 2003 when records became much more frequent; the second generation outnumbering the first. Records now until the end of October.

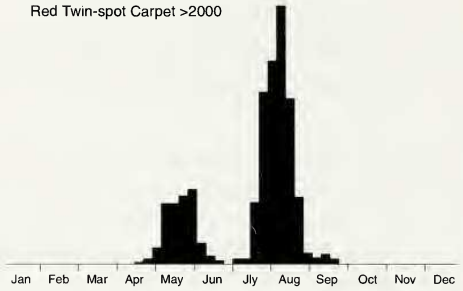
Snout *Hypena proboscidalis* (Linnaeus)
W One generation from the Midlands northwards.
Y Bivoltine from the early 1990s, the second generation now comprising 17% of total records.

Pinion-streaked Snout *Schrankia costaestrigalis* (Stephens)
W A partial second generation in southern England, late August – mid October.
Y A local moth in Yorkshire but the small number of records show a clear gap at the beginning of August and a large cluster of records in September. This strongly suggests a regular second brood.

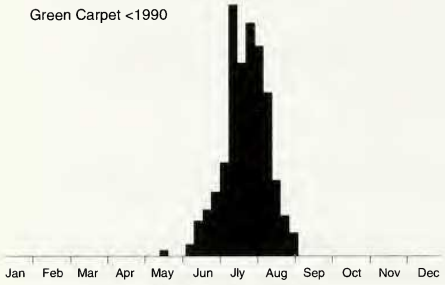
I have chosen the following histograms to illustrate some of the changes in flight times described above with comparisons before and after 2000, or in other cases comparing the situation before 1990 to records after 2000 in order to make the changes more clear.

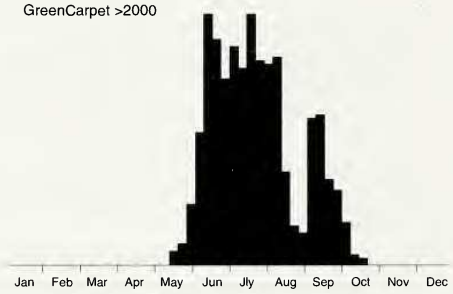
Red Twin-spot Carpet *Xanthorhoe spadicearia* and **Dark-barred Twin-spot Carpet** *Xanthorhoe ferrugata*: both species are clearly bivoltine in Yorkshire with well separated broods.



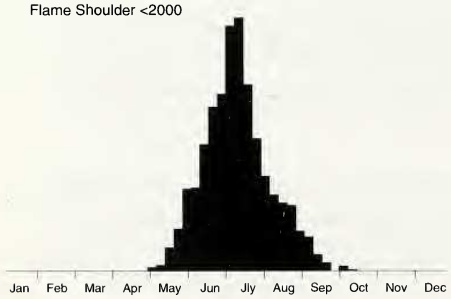


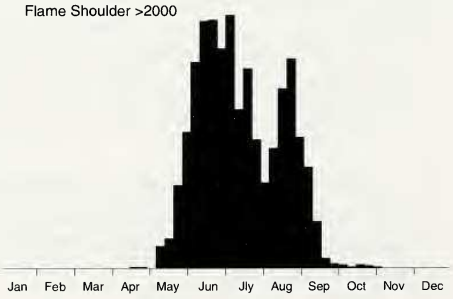
Green Carpet *Colostygia pectinataria*: univoltine before 1990 with a peak in late July and no hint of what was to come. After 2000, a significant number of moths are appearing in early June and producing a second generation in September.



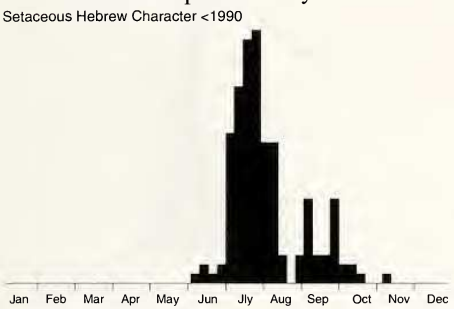


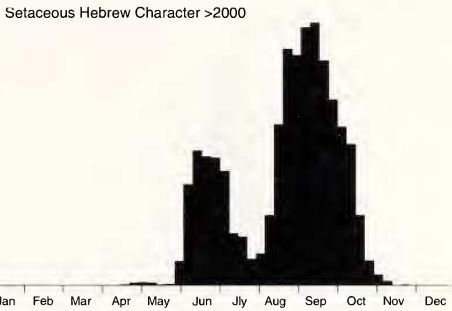
Flame Shoulder *Ochropleura plecta*: a dramatic change. Before 2000 a single brood peaking in early July with hardly a hint of a second brood. After 2000, the first brood peaks two weeks earlier in late June, and there is a significant second brood peaking in late August. An interesting scatter of even later records in October has occurred in the last few years.



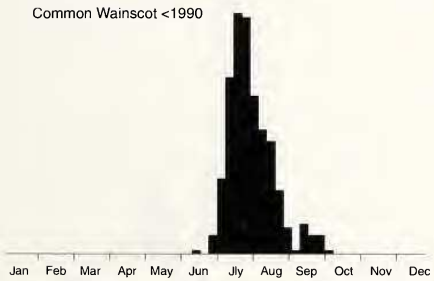


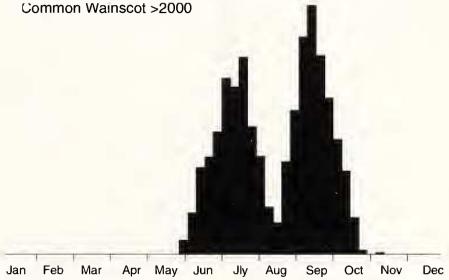
Setaceous Hebrew Character *Xestia c-nigrum*: records have gradually increased in Yorkshire as this moth has become much more common. Recent records show that the first brood now peaks earlier in June, and we now have a much larger second brood which continues to grow. There have also recently been some interesting early records in April and May.



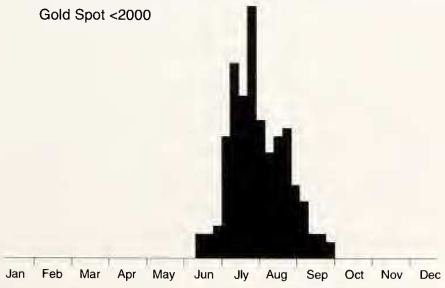


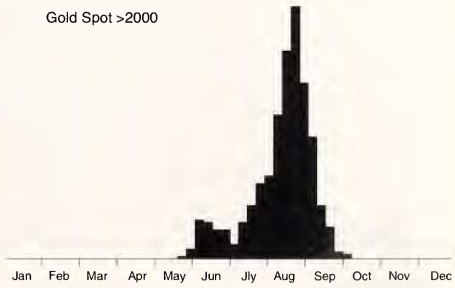
Common Wainscot *Mythimna pallens*: before 1990, a few scattered late records hinted of a second brood. Now the first brood peaks much earlier in late June/early July and there is a strong regular second brood outnumbering the first brood.



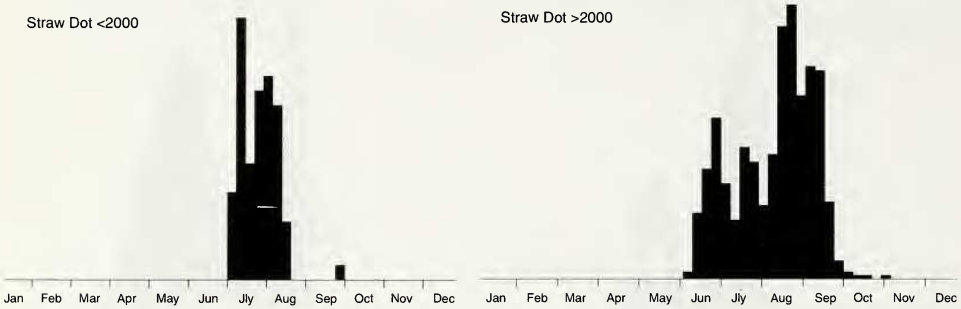


Gold Spot *Plusia festucae*: before 2000 the records suggest a single brood in most years in July and August, with a possible second brood in warmer years. After 2000 there is no doubt that the species has become bivoltine. A large second brood dwarfs the earlier June brood which looks correspondingly tiny in the illustration, though in fact the moth has become commoner in Yorkshire and recent June records are in fact greater in number than July/August records before 2000.

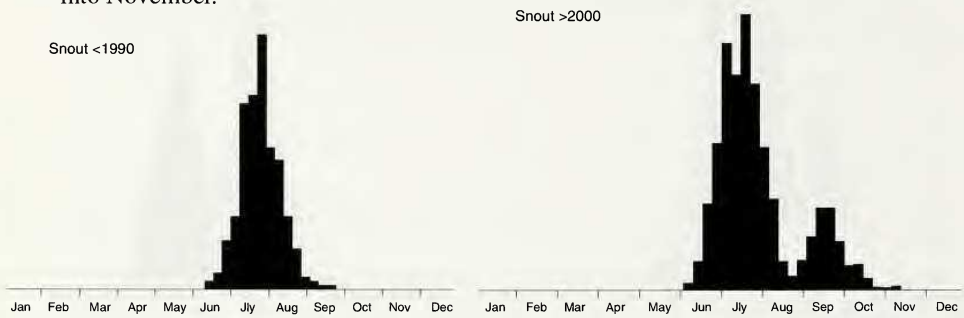




Straw Dot *Rivula sericealis*: this is another moth which has greatly increased in numbers and range in the county in the last few years. A single brood in July and August has now given way to two broods, the first in June/July and a larger second one in August/September with scattered late records now into November.



Snout *Hypena proboscidalis*: before 1990 a single brood peaking in late July. Since 2000, the first brood is perhaps a week or so earlier though the changes are slight. There is however a significant second brood in September with records extending into November.



Discussion

Yorkshiremen (and women!) generally do not take kindly to being called southerners and new moth recorders in Yorkshire may be puzzled that species which are clearly bivoltine here are said to be univoltine according to Waring and Townsend. Yorkshire is probably near the geographical centre of Britain, yet of the 18 commonly recorded species said to be bivoltine in "the south" or "the south of Britain", 16 have a clear second generation in Yorkshire every year; one (Tawny-barred Angle *Macaria liturata*) has had late individuals in recent years suggestive of a partial second brood, and only Common White Wave *Cabera pusaria* would seem to be always univoltine. By no stretch of the imagination can Yorkshire be said to be in southern England, yet of 23 common species said to be bivoltine in "the south of England", 11 have a clear second brood in Yorkshire, five are probably double

brooded in most years, and five more often have late individuals suggestive of a second brood. Only two species, Knot Grass *Acronicta rumicis* and Nut-tree Tussock *Colocasia coryli* so far have no evidence at all of any late moths. Many species are described as having partial or occasional second broods in southern England, and many of these show clear evidence of regular second broods in Yorkshire, for example Burnished Brass *Diachrysia chrysitis* and Small Blood-vein *Scopula imitaria* which have a small second brood almost every year.

Many of the examples above can be explained by inaccurate data being perpetuated in the published literature; for example there is little evidence that Nutmeg *Discestra trifolii* has ever been univoltine in Yorkshire. The majority of examples, however, seem to be part of a long term trend towards bivoltinism or indeed multivoltinism which has gathered pace in the run of warm summers of recent years. Many species are now beginning to show occasional late individuals and these are likely to represent the beginnings of a regular second brood which can only become more prominent as the pace of climatic change continues to accelerate. There are over twenty species which fit this pattern, and I strongly suspect that if the situation is revisited in another ten years, then moths such as Rivulet *Perizoma affinitata*, Poplar Hawk-moth *Laothoe populi*, Spectacle *Abrostola tripartita*, Light Emerald *Campaea margaritata*, Dark Arches *Apamea monoglypha,* Heart and Dart *Agrotis exclamationis* and many others will have become regularly bivoltine in Yorkshire.

Acknowledgements

I would like to thank the ever-growing numbers of moth recorders in Yorkshire for submitting their records to the county database over the years. Whilst records from one trap may seem to be of limited value on their own, the sum of so many records makes long term trends so much easier to analyse. I would also like to thank Mr Harry E Beaumont for his helpful comments and suggestions on the first draft of this paper.

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